

### **REMARKS**

Claims 7-20 are all the claims presently pending in the application. Claims 7-14 have been amended to more particularly define the invention. Claims 15-20 have been added.

It is noted that the claim amendments are made only for more particularly pointing out the invention, and not for distinguishing the invention over the prior art, narrowing the claims or for any statutory requirements of patentability. Further, Applicant specifically states that no amendment to any claim herein should be construed as a disclaimer of any interest in or right to an equivalent of any element or feature of the amended claim.

Claims 11 and 12 stand rejected under 35 U.S.C. § 112, second paragraph as allegedly being indefinite.

Claims 7-10 stand rejected under 35 U.S.C. § 102(b) as being allegedly unpatentable over Oshita et al. (JP 10-289731). Claims 7-10 stand rejected under 35 U.S.C. § 102(b) as being allegedly unpatentable over Noma et al. (JP 05-242891). Claims 7-10 stand rejected under 35 U.S.C. § 102(e) as being allegedly unpatentable over Fujimoto et al. (US 2003/0180617).

Claims 11-14 stand rejected under 35 U.S.C. § 103(a) as being allegedly unpatentable over Numata et al. (JP 2000-077071) in view of Oshita.

These rejections are respectfully traversed in view of the following discussion.

#### **I. THE CLAIMED INVENTION**

An exemplary aspect of the claimed invention (e.g., as recited in claims 7 and 8) is directed to a positive active material including a composite oxide which includes lithium (Li), manganese (Mn), nickel (Ni), cobalt (Co), and oxygen (O) and is represented by the following chemical composition formula:  $\text{Li}_a\text{Mn}_b\text{Ni}_c\text{Co}_d\text{O}_e$ .

Importantly, in this exemplary aspect of the claimed invention, the composite oxide includes an oxide which is other than  $\text{LiMn}_{0.05}\text{Ni}_{0.05}\text{Co}_{0.9}\text{O}_2$ , and  $b \neq 0.1$ .

Another exemplary aspect of the claimed invention (e.g., as recited in claims 11 and 12) is directed to a non-aqueous electrolyte battery, including a positive electrode which includes a lithium-manganese oxide (A) having a spinel structure and represented by the general formula

$\text{LiMn}_2\text{O}_4$  and a lithium-nickel-manganese-cobalt composite oxide (B) having an  $\alpha\text{-NaFeO}_2$  layer structure and represented by the general formula  $\text{Li}_a\text{Mn}_b\text{Ni}_c\text{Co}_d\text{O}_e$ .

Importantly, in this exemplary embodiment, a weight ratio of (A) to (B) is in a range from 5:95 to 10:90.

## II. THE 35 U.S.C. § 112, SECOND PARAGRAPH REJECTION

The Examiner alleges that claims 11 and 12 are indefinite. Applicant notes, however, that these claims have been amended to address the Examiner's concerns.

Thus, Applicant respectfully submits that these claims are clear and not indefinite.

In view of the foregoing, the Examiner is respectfully requested to withdraw this rejection.

## III. THE ALLEGED PRIOR ART REFERENCES

### A. Oshita, Noma and Fujimoto

The Examiner alleges that each of Oshita, Noma and Fujimoto anticipate the invention of claims 7-10. Applicant submits, however, that there are features of the claimed invention that are not taught or suggested by either Oshita, Noma or Fujimoto.

However, Applicant submits that neither Oshita, nor Noma nor Fujimoto teaches or suggests a composite oxide having the formula  $\text{Li}_a\text{Mn}_b\text{Ni}_c\text{Co}_d\text{O}_e$ , where the composite oxide includes an oxide which is other than  $\text{LiMn}_{0.05}\text{Ni}_{0.05}\text{Co}_{0.9}\text{O}_2$ , and  $b \neq 0.1$ .

Clearly, this feature is not taught or suggested by Oshita, Noma or Fujimoto.

Indeed, Oshita et al. (JP 10-289731) contains, in Examples thereof, a specific description of a composition represented by  $\text{LiMn}_{0.05}\text{Ni}_{0.05}\text{Co}_{0.9}\text{O}_2$ , which is expressly excluded from the claimed invention of claims 7-8.

Further, Noma et al. (JP 05-242891) contains, in Example (Fig. 2) thereof, a specific description of a composition overlapping with the claims of the present application in the case of  $b = 0.1$ , which is expressly excluded from the invention of claims 7-8.

Fujimoto et al. (US 2003/0180617) contains a specific description on compositions

represented by  $\text{LiMn}_{0.33}\text{Ni}_{0.33}\text{Co}_{0.33}\text{O}_2$ ,  $\text{LiMn}_{0.4}\text{Ni}_{0.4}\text{Co}_{0.2}\text{O}_2$ , and  $\text{LiMn}_{0.5}\text{Ni}_{0.5}\text{O}_2$ , but these do not teach or suggest the claimed invention (e.g., are not within the scope of the claimed invention).

An exemplary aspect of the claimed invention is directed to “a non-aqueous electrolyte battery which has a high energy density and is excellent in high-rate discharge performance and high-temperature charge performance” (see Application at page 8, lines 6 to 9) which is obtained by using a positive active material having the composition range as recited in the claims. The technical basis of the claimed invention is described in the specification together with the data in detail.

In particular, because each cited reference is silent about the advantage of excellent high-temperature charge performance and the advantage is extraneous, the advantage cannot be expected from the cited references.

That is, the present application describes that:

*“There has further been a problem that when the  $\text{LiCoO}_2$  is charged at a high temperature, lithium ions tend to be excessively extracted. When excessive extraction of lithium ions occurs during charge, the negative-electrode side functions to incorporate the excess lithium thereinto. That part of the lithium which remains undoped during this charge is thought to deposit as lithium metal on the negative electrode. The lithium metal which has thus deposited hardly redissolves to become utilizable as an active material. Because of this, not only the battery capacity decreases, but also there has been a possibility that the lithium deposited might penetrate the separator to cause internal short-circuiting”* (Application at page 4, bottom line to page 5, line 12).

The excellent “high-temperature charge performance” in the present application may be construed to mean that “excessive extraction of lithium ions” occurs.

On the other hand, the alleged advantages as described in the alleged references are as follows:

1) Oshita et al (JP 10-289731): “self-discharge” performance, “60°C cycle test” performance;

2) Noma et al (JP 05-242891): increase in discharge capacity, improvement in cycle characteristics; and

3) Fujimoto et al (US2003/0180617): high-rate discharge performance.

Accordingly, an advantage of the claimed invention is an extraneous one which is basically different from those of the cited references.

It is further clear that the “high-temperature charge performance” in the claimed invention is basically different from the self-discharge performance and cycle performance in the cited references. That is, there is described on page 58, lines 1 to 19 in the present Application that:

*“(High-Temperature Charge Test)*

*A high-temperature charge test was conducted in the following manner.*

*With respect to each of the batteries of Examples 1 to 8 and batteries of Comparative Examples 1 to 4, two or more battery samples in an end-of-discharge state were prepared. These batteries were placed in a thermostatic chamber having a set temperature of 60°C, and the temperature of the batteries was ascertained with a contact thermometer to have fully reached 60°C. Thereafter, constant-current constant-voltage charge at 0.2 ItA (5 hour rates) and 4.2 V was conducted, and the charge ampere hour was measured. Using the following equation, the 'high-temperature charge capacity increase ratio (%)' was calculated. High-temperature charge capacity increase ratio (%) = {(charge amperehour in high-temperature charge test) - (charge amperehour in initial charge/discharge test)}/(charge amperehour in initial charge/discharge test) × 100”*

#### **New claims 15-16 and 17-18**

In the Background section of the present Application, it is described that “in large batteries intended to be used in electric motorcars or power storage, the active materials to be used in the electrodes are required to have high thermal stability, for example, because the electrodes have a large size and the batteries are susceptible to heat buildup.” (see Application at

page 5, lines 13 to 18 thereof). Accordingly, an object of the claimed invention is to provide an active material having the high thermal stability characteristic.

However, as it is described in the Background section of the present Application that “the  $\text{LiNiO}_2$  has problems that it has a lower discharge potential than the  $\text{LiCoO}_2$  although it has a high theoretical discharge capacity, and that the active material has poor thermal stability in charged state. There are hence many unsolved problems in putting this active material into practical use.” (see Application at page 3, lines 2 to 7). The Application also provides that:

*“Many investigations are being made also on materials represented by the chemical composition formula  $\text{LiCo}_x\text{Ni}_{1-x}\text{O}_2$ . This kind of active material is thought to be based on the idea that the merits of both of two active materials, i.e.,  $\text{LiCoO}_2$  and  $\text{LiNiO}_2$ , are imparted by utilizing the fact that  $\text{LiCoO}_2$ - $\text{LiNiO}_2$  forms a solid solution throughout the whole compositional range. However, due to the introduction of nickel, this active material also has poorer thermal stability during charge than the  $\text{LiCoO}_2$  described above. In this point, this active material is not superior in properties to the  $\text{LiCoO}_2$ .” (see Application at page 3, line 8 up to page 4, line 3).*

Accordingly, it is known that an active material having such a structure that a part of Co in  $\text{LiCoO}_2$  is replaced with Ni is deteriorated in the thermal stability characteristic as compared with  $\text{LiCoO}_2$ , which causes a problem.

In the "Disclosure of the Invention" section of the present Application, although an active material of the claimed invention may include an active material as described as

*“(1) A positive active material comprising a composite oxide which is constituted of at least lithium (Li), manganese (Mn), nickel (Ni), cobalt (Co), and oxygen (O) and is represented by the following chemical composition formula:  $\text{Li}_a\text{Mn}_b\text{Ni}_c\text{Co}_d\text{O}_e$  (Chemical composition formula 1) (wherein  $0 < a \leq 1.3$ ,  $|b-c| \leq 0.05$ ,  $0.6 \leq d < 1$ ,  $1.7 \leq e \leq 2.3$ ,  $b+c+d=1$ ).” (see Application at page 7, lines 7 to 17),*

an unexpected advantage of the claimed invention is described by stating that:

*"it is desirable that manganese and/or nickel be present in the composite oxide. Namely, it is preferred that  $b > 0$  and/or  $c > 0$ . In case where manganese is not present in the composite oxide (B) in a non-aqueous electrolyte battery, this battery tends to have poor thermal stability."*(see Application at page 15, lines 11 to 16).

That is, it is provided that the thermal stability characteristic may be excellent in the presence of Mn. The inventors of the claimed invention found the following unexpected advantage and the claimed invention can be achieved based on the finding. That is, when an active material having such a structure that a part of Co in  $\text{LiCoO}_2$  is replaced with both Ni and Mn and the amount of Ni to be replaced and that of Mn is almost the same, even if Ni is mixed therein, the thermal stability characteristic is not deteriorated but improved in the presence of Mn.

Then, with respect to claims 15 and 16, a superior thermal stability in the case of  $0.8 \leq d \leq 0.833$  than in the case of  $0.833 < d \leq 1$  will be shown by specific examples.

Thermal stability was evaluated for certain batteries described in Examples of the specification.

Employed were four batteries having active materials "B04-a", "B05-b", "B-Co" and "B11-a" in Table 2 of the specification of the present Application. For the purpose of facilitating the following description, the four active materials are summarized in relation to the value d and the corresponding batteries are re-numbered as 1 to 4, as shown in the following table:

	composition	$ b - c $	d
1	$\text{LiNi}_{0.165}\text{Mn}_{0.165}\text{Co}_{0.67}\text{O}_2$	0	0.67
2	$\text{LiNi}_{0.0835}\text{Mn}_{0.0835}\text{Co}_{0.833}\text{O}_2$	0	0.833
3	$\text{LiNi}_{0.05}\text{Mn}_{0.05}\text{Co}_{0.90}\text{O}_2$	0	0.9
4	$\text{LiCoO}_2$	0	1

The active material compositions of 1 to 4 are shown in Attachment A, together with the compositional range of claim 15.

In an exemplary aspect of the claimed invention, each of the batteries 1 to 4 was prepared in the same manner as described in the specification of the present application (Application at page 69, line 7 from the bottom to page 72, line 5), then subjected to an initial charge/discharge test, and again charged in the charging condition same as in the initial charge/discharge test. Then the battery was disassembled, and the positive electrode was taken out and cut into a diameter of 3.5 mm in a state having the aluminum foil current collector and containing the electrolyte, and subjected to a differential scanning calorimetry (DSC). This is an evaluation method for exactly evaluating the thermal stability of a battery (technical reference available). Measurement was conducted by executing a temperature scan from the room temperature (25°C) to 500°C, under a temperature elevating rate of 5°C/min, and investigating the exothermic behavior.

In evaluating the thermal stability of a battery by the DSC result, it is important to investigate the initial exothermic behavior closest to the room temperature which is the temperature of actual use of the battery, and a smaller exothermic amount is considered to indicate a better thermal stability of the battery.

As a result of DSC measurement, the exothermic behavior closest to the room temperature, most important in evaluating the thermal stability of battery, was observed at about 230°C, so that a comparison was made by the magnitude of the exothermic peak ( $\mu\text{W/g}$ ) per unit mass of the positive electrode active material, as shown in the following table:

	d	mW/g
1	0.67	9
2	0.833	11
3	0.9	15
4	1	20

As will be apparent from these results, the thermal stability of the battery may improve (e.g., become better) for a smaller value  $d$  of the positive electrode active material, contained in the positive electrode. More specifically, it is evident that the positive electrodes utilizing active materials of  $d = 0.67$  and  $d = 0.833$  (corresponding to the batteries 1 and 2) are superior in the thermal stability, in comparison with the positive electrodes utilizing active materials of  $d = 0.9$  and  $d = 1$  (corresponding to the batteries 3 and 4).

As a reference, in these measurements, a comparison was also made on the magnitude of exothermic peak on a second exothermic behavior, observed at about 240 to 257°C, subsequent to the aforementioned initial exothermic behavior observed at about 230°C, as shown in the following table:

	$d$	mW/g
1	0.67	16
2	0.833	22
3	0.9	24
4	1	30

Also by referring to these results, it is understood that the thermal stability of the battery becomes better for a smaller value  $d$  of the positive electrode active material, contained in the positive electrode. More specifically, it is evident that the positive electrodes utilizing active materials of  $d = 0.67$  and  $d = 0.833$  (corresponding to the batteries 1 and 2) are superior in the thermal stability, in comparison with the positive electrodes utilizing active materials of  $d = 0.9$  and  $d = 1$  (corresponding to the batteries 3 and 4).

As indicated from the foregoing results, a battery excellent in thermal stability can be obtained by employing an active material of a structure in which, in  $\text{LiCoO}_2$ , a part of Co is substituted by Ni and Mn with approximately same amounts of Ni and Mn to satisfy a condition  $0.8 \leq d \leq 0.833$ . **This result is entirely unexpectable from the prior knowledge about the**



**case without Mn, that “an active material of a structure in which, in  $\text{LiCoO}_2$ , a part of Co is substituted by Ni deteriorates the thermal stability in comparison with  $\text{LiCoO}_2$ ”.**

The Examiner is also directed to Attachment C which provides page 329 of “*Denchi Binran (Battery Handbook) 3rd edition*” (Maruzen Co.) (and an English language translation of the excerpt on page 329, left-hand column, line 4 from the bottom to right-hand column, line 13 from the bottom) (hereinafter the “*Battery Handbook*”). The *Battery Handbook* describes that, on  $\text{LiCoO}_2$  and  $\text{LiNiO}_2$ , “thermal safety of each composition in the presence of liquid electrolyte is also investigated by thermal analyses such as DSC.”

Thus, in short, neither Oshita, nor Noma, nor Fujimoto teach or suggest a composite oxide includes an oxide which is other than  $\text{LiMn}_{0.05}\text{Ni}_{0.05}\text{Co}_{0.9}\text{O}_2$ , and  $b \neq 0.1$ .

Therefore, Applicant submits that there are features of the claimed invention that are not taught or suggested by Oshita, Noma or Fujimoto. Therefore, the Examiner is respectfully requested to withdraw this rejection.

#### **B. Numata**

The Examiner alleges that Numata would have been combined with Oshita to form the invention of claims 13, 14, 19 and 20. Applicant submits, however, that even if combined, the combination would not teach or suggest each and every element of the claimed invention.

Indeed, Applicant submits that the references provide no motivation or suggestion to urge the combination as alleged by the Examiner. Indeed, these references clearly do not teach or suggest their combination. Therefore, Applicant respectfully submits that one of ordinary skill in the art would not have been so motivated to combine the references as alleged by the Examiner. Therefore, the Examiner has failed to make a prima facie case of obviousness.

Moreover, Applicant submits that neither Numata, nor Oshita, nor any alleged combination thereof teaches or suggests “*wherein a weight ratio of (A) to (B) is in a range from 5:95 to 10:90*”, where “A” is lithium-manganese oxide and “B” is a layer-structure oxide.

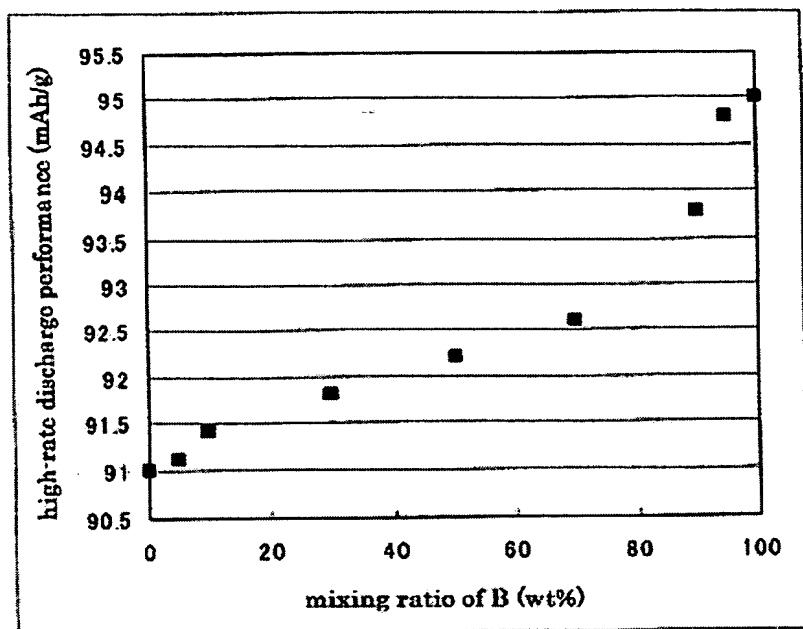
Clearly, this feature is not taught or suggested by Numata and Oshita.

An advantage of the claimed invention is, as described in the specification, “to provide a

non-aqueous electrolyte battery which retains the high thermal stability characteristic of lithium-manganese oxides having a spinel structure, has a high energy density and excellent high-rate discharge performance, is inhibited from suffering self-discharge, and has excellent storage performance”, and, in particular, the high-rate discharge performance can be significantly improved by selecting a mixing ratio of “5:95 to 10:90”.

The following table is a transcription of the numerical values in “Table 3” of the specification, and the following chart is a plotting thereof. As will be apparent from the chart, an inflection is observed at a mixing ratio of (B) at 90 %. Thus an unexpected effect that the high-rate discharge performance can be significantly improved by selecting a mixing ratio of (B) at 90 to 95 %.

mixing ratio of B (wt%)	high-rate discharge performance (mAh/g)
0	91
5	91.1
10	91.4
30	91.8
50	92.2
70	92.6
90	93.8
95	94.8
100	95



### **New Claims 19-20**

Claims 19 and 20 are restricted in the range of  $d$  as 0.9 or higher, and are made as  $b < 0.05$  (e.g., excluding the case of  $b \geq 0.05$ ).

The compositional range after restriction will be explained.

Attachment B shows a chart for explaining compositional range of various compositions represented by a general formula  $\text{Li}_a\text{Mn}_b\text{Ni}_c\text{Co}_d\text{O}_e$  (e.g.,  $b + c + d = 1$ ).

A bottom line Co-Ni indicates that  $b$ , representing the Mn content, is 0, and the value  $b$  increases by 0.1 for each line at an upper step. Therefore, a vertex marked as Mn of the equilateral triangle corresponds to  $b = 1$  and  $c = d = 0$ , thus indicating a composition represented by  $\text{LiMnO}_2$ .

Similarly an oblique line Mn-Co indicates that  $c$ , representing the Ni content, is 0, and the value  $c$  increases by 0.1 for each step down toward lower right. Therefore a lower right vertex marked as Ni corresponds to  $b = 0$ ,  $c = 1$  and  $d = 0$ , thus indicating a composition represented by  $\text{LiNiO}_2$ .

Similarly an oblique line Mn-Ni indicates that  $d$ , representing the Co content, is 0, and the value  $d$  increases by 0.1 for each step down toward lower left. Therefore a lower left vertex marked as Co corresponds to  $b = c = 0$  and  $d = 1$ , thus indicating a composition represented by  $\text{LiCoO}_2$ .

The compositions of new claims 19 and 20 satisfy following relations on  $b$ ,  $c$  and  $d$  in the general formula  $\text{Li}_a\text{Mn}_b\text{Ni}_c\text{Co}_d\text{O}_e$  ( $b + c + d = 1$ ):

$$|b - c| \leq 0.05$$

$$0.9 \leq d < 1 \text{ and}$$

$$\text{excluding the case of } b \geq 0.05.$$

In the general formula,  $b = c$  indicates that the coefficients are same for Mn and Ni, so that a straight line  $p$  in the chart satisfies a relation  $b = c$ . Also a straight line  $q$  satisfies a relation  $b - c = 0.05$ , and a straight line  $r$  satisfies a relation  $b - c = -0.05$ . Therefore, the condition “ $|b - c| \leq 0.05$ ” means a range defined by the straight lines  $q$  and  $r$  (including a point on the straight

lines).

A straight line  $s$  satisfies  $d = 0.9$ , so that the condition " $0.9 \leq d < 1$ " indicates a lower left area of the straight line  $s$ , including point thereon (however excluding the vertex Co).

A straight line  $t$  satisfies  $b = 0.05$ , so that the condition "excluding case of  $b \geq 0.05$ " excludes the area on and above this straight line.

Now the relation with the cited references will be explained.

Oshita, Example 16, describes a positive electrode material that can be represented by  $\text{LiMn}_{0.05}\text{Ni}_{0.05}\text{Co}_{0.9}\text{O}_2$ . This compositional position is indicated by a mark • in the chart of Attachment B.

In addition, the Oshita, claim 2, contains a description " $\text{Li}_a\text{Co}_b\text{Mn}_c\text{M}_d\text{Ni}_{1-(b+c+d)}\text{O}_2$  (in which M represents at least a metal selected from B, Al, Si, Ti, Fe, V, Cr, Cu, Zn, Ga and W, and which satisfies conditions  $0 < a < 1.2$ ,  $0.1 \leq b < 1$ ,  $0.05 \leq c < 1$ ,  $0 \leq d < 1$  and  $0.15 \leq b + c + d < 1$ )". This compositional range, in the case that M has a coefficient  $d = 0$ , corresponds to a range, in the chart of Attachment B, surrounded by straight lines  $t$  and  $u$ , and oblique line Mn-Co. (Note that " $c$ " indicates the amount of Mn in Oshita, whereas " $b$ " indicates the amount of Mn in the present Application).

Therefore, the compositional range of new claims 19 and 20 is not taught or suggested by (e.g., does not include) the composition described in Example of Oshita, nor taught or suggested by (e.g., included in) the compositional range in Oshita, claim 2. Therefore, the compositional range is not taught or suggested by Oshita, and the structures of new claims 19-20 are not obvious from the combination of Numata and Oshita.

An advantage of the claimed invention, as described in the specification, is

*"to provide a non-aqueous electrolyte battery which retains the high thermal stability characteristic of lithium-manganese oxides having a spinel structure, has a high energy density and excellent high-rate discharge performance, is inhibited from suffering self-discharge, and has excellent storage performance",*

and, in particular, provides an advantage of evidently improving the high-rate discharge

performance as indicated in Table 3, by selecting  $d$  as 0.9 or higher. This evident advantage of improving the high-rate discharge performance is an unexpected advantage not suggested from Numata.

The high-rate discharge performances, in the case of a mixing ratio of 50:50, are extracted from Examples 12, 16 and Comparative Example 6 in Table 3 and summarized in the following table.

	active material of B	value $d$	mixing ratio of B (wt%)	high-rate discharge performance (mAh/g)
Example 12	B-03b	0.95	50	92.2
Example 16	B-05b	0.833	50	91.1
Comp. Ex. 6	B-15b	0.5	50	87.3

The influence of value  $d$  on such high-rate discharge performance is as described in the specification (e.g., see Application at page 84, lines 4 to 20).

Thus, it is clear that Numata does not teach or suggest that a weight ratio of (A) to (B) is in a range from 5:95 to 10:90.

Likewise, as noted above, Oshita does not teach or suggest that a weight ratio of (A) to (B) is in a range from 5:95 to 10:90. Therefore, Oshita does not make up for the deficiencies in Numata.

Therefore, Applicant submits that even if these references would have been combined, the combination would not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

#### IV. FORMAL MATTERS AND CONCLUSION

Applicant notes that the specification has been amended at page 84 to correct a

typographical error. Namely, the specification was amended at line 20 to replace the equation " $0.8 \leq c < 1$ " (which clearly includes a typographical error based the context of the equation (e.g., lines 18-19 on page 84)) with " $0.8 \leq d < 1$ "

In view of the foregoing, Applicant submits that claims 7-20, all the claims presently pending in the application, are patentably distinct over the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

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Respectfully Submitted,



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